Figure 68: View of Caisson uncler construction

Figure 69: Location of Hay Point

3.2.8. Caissons for berth at Hay Point, Queensland, Australia

Owner Utah Development Co. (now owned by Broken Hill Proprietary Co. Ltd., Melbourne)
Engineer Rendel Scott Furphy, Melbourne
Contractor Joint Venture of John Holland Constructions Pty. Ltd., Melbourne/ Christiani & Nielsen, Denmark
Post-tensioning VSL Prestressing (Aust.) Pty. Ltd., Thornleigh
Years of construction 1972-1975

Introduction

The first berth at Hay Point, capable of accommodating bulk carriers up to 120,000 deadweight tonnes (dwt) was commissioned in September 1971. It was constructed as a steel piled trestle to carry the shiploader and conveyor, with structurally separate berthing dolphins forward of and underneath the trestle. This berth was the only outlet for the export of about 10 million tonnes per annum of coal from Utah Development Company's mines at Goonyella and Peak Downs. With the introduction later of a third mine at Saraji, detailed studies indicated that a second berth would be required to handle the combined production of 15 million tonnes per annum (Fig. 69).

Fundamental Considerations

It is of interest that the first and second berths are totally different in their concepts, because the problems presented to the designers were also totally different. For the first berth, the problem was to design and construct a coal loading facility 2 km out in the open sea, in a very isolated location, whereas for the second the problem was to design and construct a coal loading facility 2 km out in the open sea, immediately adjacent to an existing installation, with a ship coming in and departing approximately every two days.

The new berth is immediately north of the existing one, from which laden ships depart northwards (Fig. 70). I n view of the exposed conditions in which the operations take place, it was evident that a partly completed structure built by conventional methods in this position would have presented a serious shipping hazard for a period of about two years until it could have been completed with all its fendering. The partly completed structure would itself also have been very vulnerable during this period.

Another major consideration was that construction of a berth piecemeal in the open sea necessitates access for men and materials in an exposed situation every day for up to two years. This proved to be a major problem during the construction of berth No. 1, as there were many days when the conditions for access were marginal or impossible. Consideration was of course given to eliminating this problem by constructing berth No. 2 using the existing approach trestle and berth head for access purposes. However, this did not offer a solution to the potential shipping hazard problem and would have resulted in serious congestion on the existing installation.

The scheme finally selected

A number of schemes were considered in detail, including caissons, jackets and a duplication of berth No. 1 using sea access only. After a detailed analysis of comparative capital cost and construction risks, concrete caissons were finally selected, some of their main advantages being as follows:

1. Absolute minimum of work to be carried out at the exposed offshore site and consequently a maximum of work in the sheltered conditions of MackayHarbour.
2. Minimum risk to shipping during the construction period.
3. Low maintenance cost.
4. A heavy caisson floats and sinks in a stable, upright position. The caisson scheme therefore allowed the fabricated steel shiploader to be transported to Hay Point on board one of the caissons after being completely erected and assembled in the calm conditions of Mackay Harbour. Elimination of the very difficult task of erecting a shiploader in the exposed conditions represented a considerable saving.

The scheme finally adopted is shown in Fig. 71. Five caissons were needed to support the approach trestle. These caissons became known as the Approach Caissons (AC). Each one consists of a prestressed concrete cellular box 17.37 m square in plan and 7.62 m deep, divided into sixteen cells. The three berth caissons (BC) have a 12.19 m square and 18.29 m high reinforced concrete cellular column on each corner. The bases of BC 1 and BC3 are 45.72 m long, 38.71 m wide and 7.92 m deep, each divided into 99 cells in plan. BC 2 is 3.96 m wider, having 110 cells to provide extra buoyancy to transport the 1,000 tonnes weight shiploader to Hay Point (Fig. 72). North of berth No. 2 two mooring dolphins were required; these have concrete bases identical to those of the AC's.

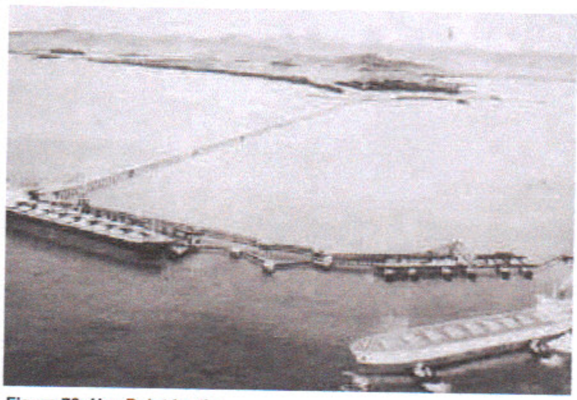

Figure 70: Hay Point berths

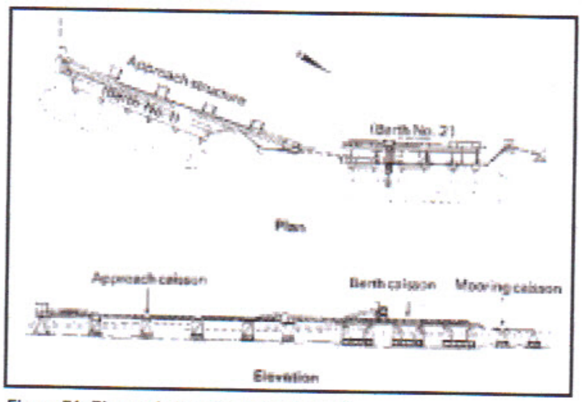

Figure 71: Plan and elevation of berth no. 2

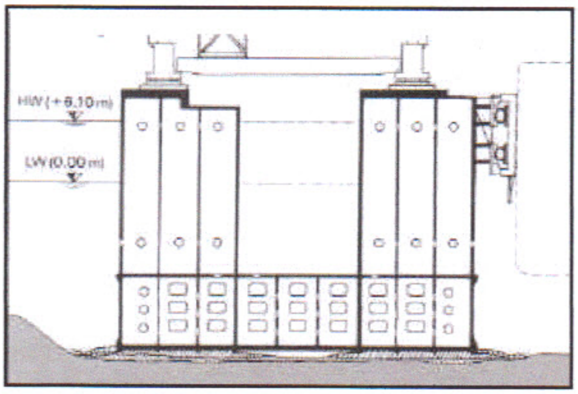

Figure 72:Cross-section of a berth caisson (BC)

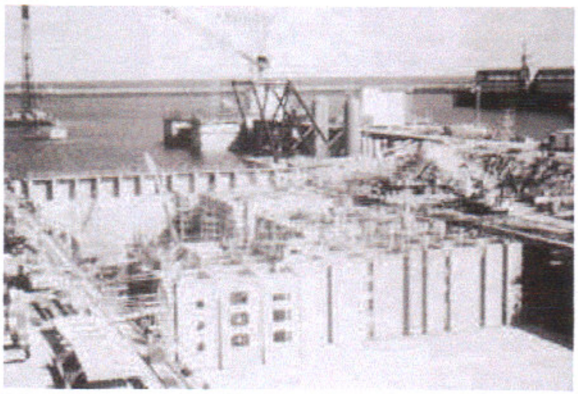

Figure 74: Construction stage (dry dock)

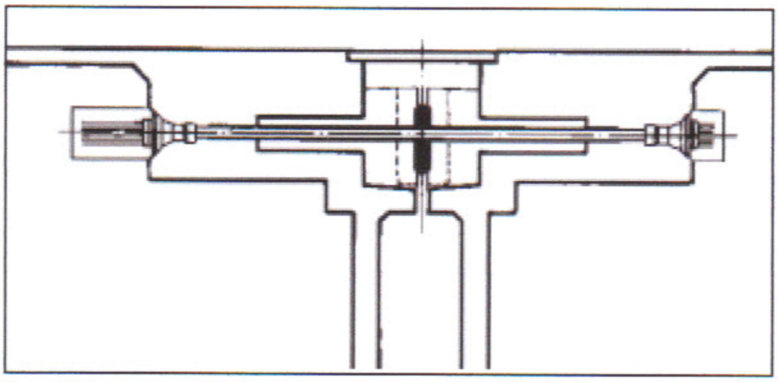

Figure 73: Section through hinge

Method of construction

The caissons were partly completed in a specially constructed temporary dry dock at the western side of Mackay Harbour. The dock was designed for use with a straddle carrier and a purpose-built overhead gantry crane, each of 350 KN capacity, to handle the precast wall units of the caissons. For obvious economic reasons the depth of the dry dock was limited to that required for partial completion of the caissons. At the fitting-out berth, at which the caissons were completed, it was necessary to seat the BC's at such a level that after completion they could be floated off at their final draft (10.67 m) at high tide.

The caissons were assembled from precast wall units varying in thickness from 203 to 406 mm with cast-in-place floors and roofs (Fig. 74). The principal reason for choosing precasting for the wall units was the existence of the somewhat conflicting requirements for thin units, to limit the draft of the caissons when afloat, and very durable concrete, to ensure the necessary life of the structure in sea-water. For substantially the same reasons, it was decided to post-tension the caissons horizontally, except for the BC columns.

Undoubtedly the principal criterion underlying the whole design was the assurance of absolute safety during the towing and sinking operation. This led to an early decision that the caissons must remain afloat and stable even in the event of major damage to an outer wall, or to the floor and roof.

The wave forces on the caisson were estimated by means of a hydraulic model at the University of Queensland. Two other model tests to investigate the floating and towing characteristics of the caissons were undertaken at the Universities of N.S.W. and Melbourne respectively. The structural design of the caissons required the checking of a large number of different loading cases.

Post-tensioning

An average prestress of about 5.3 N/mm^2 was used in the horizontal direction to cater for the various load cases. A loss of 1.4 N/ mm^2 in the floor and roof and a similar gain in the walls was calculated on the basis of the differential shrinkage effects.

In total 1,885 VSL cables of types 5-12 and 5-19, of 18 to 45 m length, were installed. Thus 680 tonnes of strand were used. The cables were either pre-assembled and fed into the ducts by winches or the VSL Pushthrough Method was applied. The latter method was judged to have particular advantages for the shorter cables. The tendons were stressed from one end only, 50% of them from one face and 50% from the opposite face (Fig. 75).

3.2.9. Caisson pile caps for Yokohama Bay Bridge, Japan

Owner and Engineer
Metropolitan Expressway
Public Corporation, Yokohama

Contractor and Post-tensioning
Joint Venture of Taisei
Corporation /Maeda Construction
Co. Ltd./Shimizu Construction Co.
Ltd., Tokyo

Years of construction
1982-1986

On September 27, 1981, the foundation stone was laid for the Yokohama Bay Bridge. This will come into service in 1989. It is a two-storey motorway bridge with six traffic

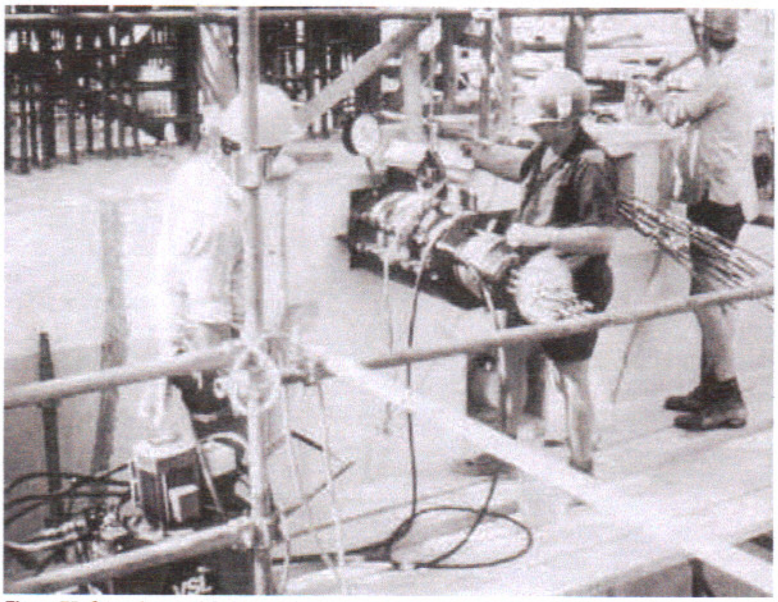

Figure 75: Stressing work being carried out